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Exercise 1: Finite difference quotient

a) $f''(x) \approx$

$$f(x+\Delta x) - f(x) - f'(x)\Delta x + \frac{f''(x)}{2!}(\Delta x)^2$$

$$f(x-\Delta x) - f(x) = -f'(x)\Delta x + \frac{f''(x)}{2!}(\Delta x)^2$$

$$\Rightarrow \quad f''(x) = \frac{f(x+\Delta x) - 2f(x) + f(x-\Delta x)}{(\Delta x)^2}$$

b) $$f'''(x) \approx \frac{f(x+2\Delta x) - 2f(x+\Delta x) + 2f(x-\Delta x) - f(x-2\Delta x)}{2(\Delta x)^3}$$

c) $$f''''(x) \approx \frac{f(x+2\Delta x) - 4f(x+\Delta x) + 6f(x) - 4f(x-\Delta x) + f(x-2\Delta x)}{(\Delta x)^4}$$

b) + c) in the same scheme as in a)